

1           **CONFERENCE-TABLE-BASED WIRED INFORMATION SYSTEM**

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3           CROSS-REFERENCED TO RELATED APPLICATION

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5           This application claims the benefit of U.S. Provisional  
6         Application No. 60/403,044, filed 13 August 2002.

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8           Field of the Invention

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10          The present invention relates to a method and apparatus  
11         for efficiently converting an ordinary conference table into an  
12         easy to use multipurpose information distribution and  
13         processing system.

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15

16          Background of the Invention

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18          In today's fast moving and complex world, most non-trivial  
19         projects require the varied expertise and simultaneous efforts  
20         from multiple individual people. Often, small teams are  
21         involved; many are limited to a dozen, or fewer people.  
22         (Evidence: The vast majority of corporate conference room  
23         tables seat fewer than 12 people). Collectively, these teams

1 determine the fates of billion-dollar-programs, as well as the  
2 fates of many corporations, themselves.

3

4 Yet, it is common knowledge, among experienced meeting  
5 attendees, that groups and teams face a variety of potential  
6 communication breakdowns. Some examples are, 'incomplete  
7 sharing of critical facts', 'important clarification that goes  
8 unsought' and 'questionable logic that goes unchallenged'.  
9 Clearly, sincere and complete discussion is needed to avoid  
10 such breakdowns. Very often, sincere and complete discussion  
11 can be initiated as follows: Ask a tough question, allow the  
12 attendees to answer it anonymously, and display the vote tally  
13 (but not any individual votes). Often, group members will  
14 anonymously flag a problem that they would not flag without  
15 anonymity. Yet, when they see that others in the group share  
16 their same concern, open (sincere and complete) discussion  
17 follows. In summary, a typical sequence is, "ask tough  
18 question #1, display the anonymous tally, engage in 'somewhat  
19 open' discussion, ask tough question #2, display the anonymous  
20 tally, engage in even more open discussion". This anonymous-  
21 polling-sequence can be used numerous times in a single  
22 meeting. However, it must be fast, convenient, easy to learn,  
23 and easy to use.

1           An unmet need exists for truly practical conference-table-  
2       based polling systems. This is evidenced by today's lack of  
3       any kind of instant polling capability in millions of corporate  
4       conference rooms, where numerous important face-to-face  
5       meetings take place, daily. This is further evidenced by the  
6       complete global absence of any truly practical conference-  
7       table-mounted polling capability.

8

9           While 'audience response systems' do exist, they are  
10       neither designed, nor optimized, for small conference rooms  
11       (e.g. for 12 or fewer people). They are designed for use with  
12       large crowds (e.g. hundreds or thousands of people). These  
13       systems are either wired or wireless.

14

15       It might be tempting to assume that wireless systems are  
16       always superior. However, for use around a small conference  
17       room table, these wireless systems are inherently inferior.  
18       They have numerous drawbacks, such as, a serious loss of  
19       anonymity (due to the need to see one's own keypad),  
20       unnecessarily high costs, time consuming setup and put-away  
21       (for every session), extensive training needed for the main  
22       operator, 12 or more batteries to go dead, unreliable operation  
23       due to radio frequency interference (or infrared occlusions),  
24       slow tally and display operation, complexity for users,

1 frequent loss of remote units (that become misplaced,  
2 inadvertently left at home, dropped or stolen).

3

4 Likewise, the existing wired 'audience response systems'  
5 are designed for use with large crowds (e.g. hundreds or  
6 thousands of people). As such, they are not intended for  
7 practical, permanent installation in the numerous conference  
8 rooms for 12 or fewer people. They comprise unsightly tangles  
9 of cables, connectors and large, awkward enclosures that can  
10 not be properly mounted to the conference table without  
11 seriously destroying the normal utility of the table top  
12 surface or without infringing on legroom and comfort underneath  
13 the table. Again, they too suffer a serious loss of anonymity  
14 (due to the need to see one's own keypad), unnecessarily high  
15 installation costs (if permanent installation is attempted),  
16 and time consuming setup and put-away (for every session if not  
17 a truly permanent installation).

18

19 It would be highly advantageous, therefore, to remedy the  
20 foregoing and other deficiencies inherent in prior attempts to  
21 meet the unmet need.

1           Accordingly, it is an object of the present invention to  
2       provide a new and improved conference-table-based information  
3       system.

4

5           Another object of the present invention is to provide a  
6       new and improved conference-table-based information system that  
7       provides truly anonymous polling.

8

9           Another object of the present invention is to provide a  
10      new and improved conference-table-based information system with  
11      an easy and cost-effective method for permanent or temporary  
12      installation (easy enough to be organized as a 'do-it-yourself  
13      kit').

14

15          Yet another object of the present invention is to provide  
16      a new and improved conference-table-based information system  
17      with 'instant-on' access (virtually no setup/put-away time  
18      required), virtually no obstructions placed on the table top  
19      surface, ample legroom, no sharp edges to contact knees, pants  
20      or skirts and minimal training required to use basic polling  
21      functionality.

1                   Summary of the Invention

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3         Briefly, to achieve the desired objects of the instant  
4     invention in accordance with a preferred embodiment thereof,  
5     provided is a table-based wired information system including a  
6     table having a plurality of actual positions designed to  
7     receive people, for the purpose of voting, playing games, etc.  
8     and a monitor positioned so as to be observed by people at any  
9     of the plurality of actual positions. A plurality of vote  
10    boxes, each including a switch with at least two positions, are  
11    secreted, one each, at each of the plurality of actual  
12    positions. A flat ribbon cable assembly with a plurality of  
13    electrical conductors less than the number of available  
14    positions (maximum number of potential positions of the table-  
15    based wired information system) is affixed to an under-surface  
16    of the table. The flat ribbon cable assembly is coupled to the  
17    monitor system and each of the vote boxes are coupled to the  
18    flat ribbon cable assembly intermediate the ends.

19

20         The above described objects and others are further  
21     realized in a method of mounting a table-based wired  
22     information system on a table including the following steps,  
23     which may be performed in any convenient sequence. A table is  
24     provided having a plurality of actual positions designed to

1 receive people, for the purpose of voting, playing games, etc..  
2 The table has an under-surface accessible at each of the  
3 plurality of actual positions. A monitor is positioned so as  
4 to be readable by people at any of the plurality of actual  
5 positions. A flat ribbon cable assembly includes a flat ribbon  
6 cable with adhesive backing and a plurality of electrical  
7 conductors less than the number of available positions. The  
8 flat ribbon cable assembly is adhesively attached to the under-  
9 surface of the table in a flat orientation using the adhesive  
10 backing. The flat ribbon cable is coupled to the monitor  
11 system. A plurality of vote boxes is provided with each vote  
12 box of the plurality of vote boxes including a multi-position  
13 switch. One each of the plurality of vote boxes is adhesively  
14 attached to the under-surface of the table at each of the  
15 plurality of actual positions and each of the vote boxes is  
16 coupled to the flat ribbon cable intermediate the ends by a  
17 press-on insulation displacement connector.

1                   Brief Description of the Drawings

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3                 The foregoing and further and more specific objects and  
4                 advantages of the invention will become readily apparent to  
5                 those skilled in the art from the following detailed  
6                 description of a preferred embodiment thereof, taken in  
7                 conjunction with the drawings in which:

8

9                 FIG. 1 is a top perspective view of a conference table  
10                with an installed voting system in accordance with the present  
11                invention;

12

13                FIG. 2 is a bottom perspective view of the conference  
14                table and installed voting system of FIG. 1;

15

16                FIG. 3 is a perspective view of a monitor system (e.g.  
17                display console) used in the voting system of FIG. 1;

18

19                FIG. 4A is a schematic diagram of circuitry, cables and  
20                connectors of the display console of FIG. 3;

21

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23                FIG. 4B is a schematic diagram of another embodiment of  
24                multiplexing circuitry of the display console of FIG. 3;

1  
2       FIG. 4C is a schematic diagram of another embodiment of  
3 multiplexing circuitry of the display console of FIG. 3;

4  
5  
6       FIG. 5 is a top front perspective view of a vote box used  
7 in the voting system of FIG. 1 (It should be understood that  
8 throughout the specification, the terms "top" and "bottom" are  
9 with reference to specific figures and not necessarily actual  
10 installed orientations);

11

12       FIG. 6 is a top end perspective view of the vote box of  
13 FIG. 5;

14

15       FIG. 7 is a bottom end perspective view of the vote box of  
16 FIG. 5;

17

18       FIG. 8 is a top end perspective view of an adapter box  
19 used in the voting system of FIG. 1;

20

21       FIG. 9 is a bottom end perspective view of the adapter box  
22 of FIG. 8;

23

24       FIG. 10 is an exploded perspective view of the components  
25 of the vote box of FIG. 5;

1       FIG. 11 is an exploded perspective view of the components  
2       of the adapter box of FIG. 8;

3

4       FIG. 12 is a perspective view of a self-adhesive flat  
5       ribbon cable assembly with an insulation displacing connector  
6       (IDC) in accordance with the present invention;

7

8       FIG. 13 is a perspective view illustrating a method of  
9       bonding self-adhesive ribbon cables to the undersurface of a  
10      table using wax board apparatus, in accordance with the present  
11      invention;

12

13      FIG. 14 is a perspective view of a laminating machine used  
14      to bond separately reeled adhesive and separately reeled non-  
15      self-adhesive flat ribbon cable into a single bonded lamination  
16      in accordance with the present invention; and

17

18      FIG. 15 is an enlarged perspective view of a central  
19      portion of the laminating machine of FIG. 14.

1                   Detailed Description of a Preferred Embodiment

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4                   I. Overview of the System and Environment

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6                 Turning now to the drawings and specifically to FIG. 1, a  
7                 portion of a typical conference room is illustrated. The  
8                 conference room is equipped with an embodiment of a conference-  
9                 table-based wired information system 10 in accordance with the  
10                present invention. A conference table 12 and twelve chairs are  
11                provided to accommodate up to twelve people for conference  
12                meetings. The purposes of such conference meetings can be  
13                extremely varied (as in, staff meetings, project reviews,  
14                problem solving meetings, brainstorming meetings, etc.).  
15                However, in general, group discussion is an important element  
16                in these meetings.

17

18               Referring additionally to FIGS. 2 and 3, on top of table  
19               12, is a monitor system (e.g. display console) 15, which is  
20               electrically connected by a flexible round cable 16 through an  
21               adapter box 18 and then through a flat ribbon cable assembly 20  
22               to twelve vote boxes 22, each of which has a key-switch 23,  
23               with which votes, opinions or responses are sensed. The votes  
24               are rapidly summed and this sum or tally is displayed on

1 display console 15. It will be understood that while the  
2 system described is attached to a table, in some specific  
3 applications, the voting system might be molded into the table.  
4 Here it will be understood that while display console 15 is  
5 mounted on top of table 12 for convenience, the console could  
6 be located in various positions on the table (near the center,  
7 near an end, or near a corner) or on a room wall. The  
8 preferred location is near a corner of the table, where people  
9 tend to look during a presentation. The face of the display  
10 can be about 90 degrees (97 degrees works nicely) to the table  
11 top surface, to give excellent visibility as well as requiring  
12 short lengths of wiring and security cable to reach the table's  
13 under surface. (In general, the corners of tabletops are often  
14 unoccupied during traditional meetings). An optional stand can  
15 be made with a fine wood finish (e.g. maple, cherry or walnut)  
16 in order to add visual appeal (especially for use in expensive  
17 boardrooms). Here it will be understood that the console can  
18 be securely attached to the table top via various means,  
19 including clamps that do not damage the table top. An  
20 optional infrared (IR) emitter (or transceiver) 19 can link  
21 display console 15 with a personal computer (PC) or personal  
22 digital assistant (PDA), or the like, if desired.

1       II. Typical Operation of the System

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3           People gather in the conference room and seat themselves  
4       in a chair at conference table 12. One person presses, and  
5       holds for about one second, a power button 25 on console 15.  
6       After this power-up-request is issued, a microcomputer  
7       (MCU) (described in more detail below) inside console 15 begins  
8       running. The MCU turns on all of the critical display elements  
9       so that any defective display elements can be visually detected  
10      by the people present. This feature is included to avoid any  
11      inaccurate display of the true vote tally. It also  
12      familiarizes new people with the system's display. Next, the  
13      MCU directs console 15 to make an audible sequence of tones  
14      (e.g. low-then-high pitch), confirming that this 'display test'  
15      has ended and that the system is ready to display actual vote  
16      tallies. Here it will be understood that a similar feature  
17      will be incorporated for any optional displays being used. All  
18      of this takes about three seconds. It should be noted that  
19      this feature is much faster than the extensive setups required  
20      of 'competing' wired or wireless audience response systems and  
21      much faster than starting a typical personal computer.

22

23           One person, perhaps a meeting facilitator, asks a  
24      question, directing it at the present voters (most or all of

1 the people seated at table 12). This can be just a spoken  
2 question, a written question, or both. For example, written  
3 questions, can be prepared before the meeting and projected  
4 from a notebook PC through a video projector. Alternatively,  
5 someone can simply use markers on a white board or flip chart  
6 (this is especially useful for impromptu questions). The  
7 voters think about what their individual anonymous responses  
8 will be, then either they press or don't press the vote button  
9 23 on the vote box 22 associated with their chair. Each  
10 voter's vote box 22 and button 23 is located near them, under  
11 table 12 near the table edge. The location is such that the  
12 position and movement of the voters hand is hidden from view by  
13 others, while still being easy to reach and press. The  
14 mechanical action, of pressing the button 23, is virtually  
15 inaudible due to specially selected or specially built key  
16 switches. This eliminates undesirable auditory hints of the  
17 otherwise anonymous vote. Furthermore, silent tactile feedback  
18 (e.g. an abrupt change in force that was opposing the voter's  
19 finger) confirms to the individual voter that his key switch  
20 has made electrical contact. These precautions are desired  
21 because voters are sitting in very close proximity (typically  
22 within 30 inches) of each other. Thus, the direct voting  
23 actions are secreted from voters sitting in close proximity.

1        Almost instantly, the MCU totals and displays the number  
2        of vote buttons currently being pressed. The system is  
3        potentially so fast that all vote buttons can be scanned,  
4        tallied and displayed in less than 1/60 of a second. To the  
5        voters, this scan-tally-display process seems to be  
6        instantaneous. (In fact, with a fast enough scan, the MCU  
7        could count rapid vote button press-and-release actions for  
8        every voting person, thereby further expanding the  
9        expressiveness of 'one-button' vote boxes. For example, each  
10      voter could press his/her button  $n$  times, where  $n$  is his/her  
11      selected option/choice for a multiple choice question. Here,  
12      switch de-bouncing [e.g. a resistor and/or capacitor circuit  
13      across each switch] may be necessary). Of course, if desired,  
14      the system can be run more slowly (which may be more 'self  
15      explanatory' to some voters).

16

17        Some of the kinds of questions that are effectively  
18        answered with this system are 'True/False',  
19        'True/False/Abstain', 'Multiple Choice', 'Continuous Ratings',  
20        'Likert Scale Ratings', 'Is the current topic of discussion  
21        relevant?', 'Decision Tree', 'Hyperlink Action' and 'Group  
22        navigation' questions. All can be accomplished with one vote  
23        button per voter.

1       For example, a 'True/False/Abstain' kind of question can  
2       be answered by asking two questions sequentially (e.g. Ask "Is  
3       it true?" then ask "Is it false?". Press no key to abstain.  
4       Alternatively, two vote buttons (one labeled 'true' and the  
5       other labeled 'false') could be placed in each vote box such  
6       that the voters would have to press one or the other, unless  
7       they wished to abstain. This would enable more consistent  
8       anonymity by discouraging voters from intentionally or  
9       unintentionally 'tipping their hand'. Here, 'tipping their  
10      hand' means making a 'no' vote public by showing both of their  
11      hands (far away from their vote button) throughout the voting  
12      period.

13

14       Likewise, a multiple choice question can be asked as a  
15      sequence of questions, each being answerable by "true" or  
16      "false". Since, experts in traditional polling strongly  
17      recommend that multiple choice questions contain no more than  
18      four alternatives anyway, this sequential process is very  
19      practical. The power (versatility) of single-button-voting is  
20      surprising to many people.

1        III. Component-by-Component Description of the Preferred  
2        Embodiment

3

4            A. Display Devices for Indicating Results

5

6            Illustrated in FIG. 3 is a perspective view of display  
7        console 15, which includes ultra-bright 'light emitting diodes'  
8        (LEDs) 26 equally spaced around the face of display console 15,  
9        and corresponding labels 28 (e.g. numbers). Voting results are  
10      almost instantly displayed by LEDs 26 and the corresponding  
11      labels 28. Optionally, voting results can be displayed on a  
12      computer screen (not shown), if the computer is coupled to an  
13      infrared link (described in conjunction with FIG. 4A below) in  
14      console 15. Note that the infrared link is not the only option  
15      here. For example, the display console circuit could use direct  
16      wiring to (and from) a PC. Yet another option is the use of an  
17      RF link for console to PC communications. The computer display  
18      is virtually unlimited in potential display formats. (Even  
19      without using a PC, the display portion of the display console  
20      could be wirelessly linked (using IR or RF) to the remainder of  
21      the display console, in order to allow more locations around  
22      the conference room for placing the actual display).  
23      Furthermore, a rudimentary 'vote switch scanner' could

1 wirelessly send information to both a separately enclosed  
2 display and to a PC.

3

4 In the illustrated arrangement of LEDs 26 in console 15,  
5 the vote tally can be displayed by a 'curved bar graph', in  
6 which  $n$  LEDs glow to represent a tally of  $n$  votes, where  $n$  is  
7 an integer in the range of 0 to 12. For example, if the tally  
8 is zero, then no LEDs light, and if the tally is 12, then all  
9 12 LEDs light. Alternatively, a single glowing LED  
10 representation can be used. That is, If the tally is  $n$ , then  
11 only the single LED which is labeled  $n$  is allowed to glow.  
12 Here  $n$  is an integer in the range of 1 to 12. For example, if  
13 the tally is zero, then no LEDs light and if the tally is 12  
14 then the LED adjacent the number 12 will light.

15

16 The LEDs are time multiplexed, to reduce MCU pin  
17 requirements, interconnects to (optional) remote LED displays,  
18 and to reduce the power when many LEDs seem to be  
19 simultaneously glowing. The LEDs are activated in three groups  
20 of four LEDs per group. Sweeping through all LEDs can be done  
21 quickly (e.g. faster than 16 milliseconds per complete sweep)  
22 in order to virtually eliminate a perception of flicker. Here  
23 it will be understood that other display formats are possible

1 too (e.g. seven-segment, 5x7 dot matrix, vertical stack of  
2 lights, etc.).

3

4 By placing the MCU between the PC and the under-table-  
5 network, security risks from an 'anonymity loss' are minimized.

6 That is, it is much more difficult to hack the specialized  
7 assembly language MCU code, which is rendered unreadable by  
8 blown fuses in the MCU. (To hack PC software is much easier).

9

10 If even further security is desired, encryption checks  
11 could be made as follows: Along with each vote result, a  
12 digital 'system integrity' code could be displayed and stored.  
13 After a sequence of votes, the sequence of tally values plus  
14 the sequence of system integrity codes could be uploaded via  
15 internet to a web site that responds with 'valid' or 'invalid'.  
16 If 'invalid', then tampering could have occurred. The complex  
17 encryption code would be computed in the MCU via its unreadable  
18 firmware.

19

20

21 B. Vote Sensing apparatus

22

23 Cable 16 couples information from flat ribbon cable  
24 assembly 20 and distributed vote boxes 22 to the MCU. The MCU,

1 designated 30, is illustrated schematically in FIG. 4A. Cable  
2 16 can also supply electrical power to flat ribbon cable  
3 assembly 20 and, thence, to distributed vote boxes 22, if  
4 desired, although not explicitly shown in FIG 4. For example,  
5 one could simply apply Vdd to conductor-6 and Vss to conductor-  
6 5 of flat ribbon cable assembly 20, instead of grounding both  
7 conductors. In the embodiment shown in FIG. 4A, MCU 30  
8 selectively controls the logic level (e.g. +5 volts or 0 volts)  
9 on four conductors 32 called 'group 0', four conductors 34  
10 called 'group 1', four conductors 36 called 'group 2', and four  
11 conductors 38 called 'group 3'. A high logic level (e.g. +5  
12 volts) on any group, activates that unique group of four vote  
13 boxes 22. Any activated group couples four bits of information  
14 to the MCU, representing four votes (e.g. a high logic level  
15 means 'yes, the associated button 23 is being pressed'; a low  
16 logic level means 'no, the associated button 23 is NOT being  
17 pressed, at the moment'). Four groups of diodes 40 are  
18 connected in series with the switches 23 of vote boxes 22 in  
19 each of the four groups in order to limit or electrically  
20 isolate, the number of high conductivity paths, which could  
21 otherwise result in erroneous vote tallies.

22

23 For reduced EMI, R-C filters 42 (e.g. R0 and C0) are used.  
24 This slows the voltage slew rate. However, in order to have

1 MCU 30 read the vote button switch positions correctly, pull-  
2 down resistors R8 through R11 (100k ohm resistors), generally  
3 designated 44, must discharge most of the residual charge on  
4 long ribbon cable 20 (and capacitors C0 through C3). To  
5 ensure that the discharge occurs rapidly enough, MCU 30 is  
6 programmed to momentarily switch MCU input pins on the lower  
7 left I/O port from their normal high impedance inputs to low  
8 level (low impedance) outputs, thereby pre-discharging the  
9 input 4 bit bus (before reading the 4 bit result at input pins  
10 on the lower left I/O port). It will be understood that if the  
11 same functions described above are accomplished using 'negative  
12 logic,' then pre-charging (instead of pre-discharging) can be  
13 employed.

14

15

16       C. The microcomputer (MCU 30)

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18       In this embodiment, microcomputer 30 is a low power 8 bit  
19       MCU. Low power is desirable so that the whole system can  
20       operate from a few small batteries for months. This eliminates  
21       routing wiring to the mains, an AC wall adapter, and more  
22       expensive electromagnetic interference (EMI) shielding to meet  
23       FCC regulations. There is an exception to the otherwise  
24       required FCC testing for products, if they are not connected to

1       the power mains, they use no clocks above 1 MHz and they are  
2       not conductively connected to a personal computer. (An IR link  
3       to a PC can be electrically non-conductive for EMI). An  
4       external crystal 46 determines the clock rate, which is low  
5       (about 38 kHz) in order to conserve power and reduce EMI. Two  
6       ports are essentially dedicated to scanning vote boxes 22 (each  
7       is a momentary contact, normally open, SPST switch). It will  
8       be understood by those skilled in the art that by combining  
9       vote tallies of more than 12 vote boxes, larger groups can be  
10      polled. This can be accomplished, for example, by replacing  
11      diodes 40 in FIG. 4A with transistors, as shown in FIG. 4B or a  
12      storage element, as shown in FIG. 4C.

13

14       Referring additionally to FIG. 4B, a schematic diagram of  
15      circuitry for combining the vote tally from up to 40 vote boxes  
16      is illustrated, with the diodes of FIG 4A replaced with  
17      transistors (or a digital comparator, in the general case) and  
18      one of the buses comprises five conductors instead of four  
19      conductors). Thus, the same 10 conductor ribbon cable (or  
20      fewer conductors if desired) can easily tally votes from 40  
21      vote boxes, without integrated circuits in the vote boxes (also  
22      without Vdd and Gnd conductors to the vote boxes). This can  
23      use a display format capable of displaying a vote tally of  
24      about 40. In summary, the schematic in FIG. 4B illustrates a

1 simple means of increasing the number of vote switches (and  
2 voters) for one display console like that in FIG. 4A. The  
3 bipolar NPN transistors and PNP transistors can select one of  
4 two groups, depending upon the logic state of a prime line. In  
5 addition, the transistors prevent current from flowing up  
6 through the switches that, otherwise, could yield a false vote  
7 tally reading. Note that the same functionality, arising from  
8 using bipolar transistors, can be achieved by using field  
9 effect transistors (FETs) as the switching devices (possibly  
10 with diodes to restrict the direction of current flow). Also,  
11 note that the same functionality, arising from using bipolar  
12 transistors, can be achieved by using integrated circuit (IC)  
13 gates, as long as Vdd and Vss are provided for the IC gates.  
14 The systems illustrated in FIGs. 4A, 4B and 4C all incorporate  
15 multiplexing, where the term "multiplexing" is defined in this  
16 disclosure as reuse of a small number of electrical conductors,  
17 compared to the number of available voting positions, to convey  
18 different information at different times. It should be  
19 understood that the number of voting positions actually wired  
20 into the system can be less than the available voting positions  
21 that the system can support. For example, the number of  
22 electrical conductors used will generally be less than the  
23 number of voting positions available.

1        In FIG. 4B, Thus, the same ten conductor ribbon cable can  
2        easily tally votes from forty vote boxes, without integrated  
3        circuits in the vote boxes (also without Vdd and Gnd conductors  
4        to the vote boxes). This can use a display format capable of  
5        displaying a vote tally of about forty.

6

7              D. Power Control

8

9        In FIG. 4A, field effect transistors 48 and 50 can be used  
10      to turn off the system by commands from MCU 30. A console  
11      power-mode switch 52 (a momentary contact, normally open, SPST  
12      switch) can turn on the system. This is done by providing a  
13      temporary path for power to MCU 30 which then turns on a 'keep  
14      on' logic level 54 to keep the power FET on, until MCU 30  
15      issues a 'turn-off-the-system' command. FET 50 is used to  
16      shunt to ground any power that may arrive from a (directly  
17      wired) PC interface (which might otherwise prohibit the  
18      complete turn off of the system).

19

20              E. Interface to a personal computer (PC)

21

22        As stated elsewhere, a PC can be included, if desired, to  
23        expand the functionality of the basic 'PC-less' system. Thus,  
24        a few MCU pins are dedicated to input and output from and to an

1 optional PC 56. In this embodiment, an infrared link 58 is  
2 used to couple PC 56 to an output lead 59. Note that infrared  
3 link is not the only option here and a direct wiring to (and  
4 optionally from) a PC or a radio frequency (RF) link for  
5 console to PC communications could be used, if desired.

6

7           F. Mode Setting

8

9           Although there is only one console power switch 52, it can  
10 perform multiple tasks. If power is off, a brief press will  
11 turn on power. If power is on, a sustained press and hold (for  
12 over 3 seconds) turns the power off. If power is on, a very  
13 brief tap (< 2 seconds) can enter a mode setting process, in  
14 which LEDs sequentially glow. Here, each LED can have an  
15 associated action (e.g. 'turn sound off'). A second tap, at  
16 the appropriate time (when the associated LED is glowing) can  
17 initiate the associated action. Each or all of these modes can  
18 be easily programmed into MCU 30 in a well known fashion.

19

20           G. Cables

21

22           Cable 16 is an easily flexed, round cross-section, cable  
23 that connects the MCU ports to adapter box 18. (Note: Adapter  
24 box 18 could be omitted and a more direct connection made from

1 ribbon cable 20 to the MCU ports. However, there are  
2 drawbacks. In the preferred embodiment ribbon cable 20 is a  
3 self-adhesive-ribbon-cable. In the direct connection  
4 embodiment, some fraction of the self-adhesive-ribbon-cable  
5 would have to be left without adhesive. Also, flat ribbon  
6 cable assembly 20 is awkward and unsightly for customers to  
7 work with. Furthermore, flat ribbon cable assembly 20 could  
8 develop open circuits if flexed excessively. Finally, if  
9 cable 16, with the round cross section, is often flexed,  
10 plugged in or unplugged and becomes defective, it can be simply  
11 replaced, if adapter box 18 is included.

12

13 An optional cable, which in this embodiment is an easily  
14 flexed, round cross-section cable similar to cable 16, is used  
15 to connect one or more MCU I/O ports to an IR emitter or  
16 transceiver or more directly to a PC port (e.g. a parallel  
17 printer port). Through the optional cable, MCU 30 can report  
18 the sum of individual votes, without revealing the individual  
19 votes themselves, to a remotely located PC. (It will be  
20 understood that this cable can be eliminated if the infrared  
21 emitter or transceiver is mounted directly on the main printed  
22 circuit board).

1           H. Vote Box

2

3           Nearby each voting person around table 12 is a vote box 22  
4       in a specially designed housing. As shown in FIGS. 5, 6, and  
5       7, push button switch 23 with a keycap is mounted inside  
6       specially designed housing 65. Housing 65 is typically  
7       fastened to the undersurface of conference table 12, well  
8       within easy reach of the voting person (e.g., about one inch to  
9       three inches from the tables outer edge). The voting person  
10      simply presses push button switch 23 upward, toward the table  
11      top. Alternatively, if the vote box is equipped with an  
12      optional FBLRU-type control (substantially similar a well known  
13      joystick), the voting person pushes Forward, pulls Backward,  
14      pushes Left, pushes Right or pushes Upward to record their  
15      vote.

16

17       Push button switch 23 is recessed within a hole in housing  
18      65 that is chamfered to allow comfortable finger access to  
19      fully depress push button switch 23. All edges of housing 65  
20      that could be accidentally bumped by a person's knee, pant  
21      legs, skirt or hand are devoid of sharp edges. The overall  
22      height (indicated as 66 in FIG. 6) of housing 65 should be as  
23      small as is practical, in order to maximize unobstructed  
24      legroom under the table.

1        Furthermore, the edges (front and sides) of the enclosure  
2        are of sufficiently large radius so as to deflect much of any  
3        bumping force upward into the rigid table undersurface. That  
4        is, a person's knee should be gently deflected under the vote  
5        box enclosure, rather than abruptly (painfully) impacting any  
6        vertical edge of the vote box enclosure. Toward this goal, the  
7        front edges and end edges are of large radius as illustrated in  
8        FIGS. 5 and 6 (or can be sloped at about 45 degrees).

9

10       An opening 68 in the bottom of housing 65 is chamfered to  
11       easily guide a mating electrical connector 70 (see the exploded  
12       view in FIG. 10) in vote box 22, into mating engagement with a  
13       header 72. A printed circuit board 78 contains a switch 76  
14       (momentary contact, normally open, SPST, silent action, with  
15       tactile feedback). Switch 76 is covered by a keycap and forms a  
16       portion of switch 23. Printed circuit board 78 is electrically  
17       coupled to another printed circuit board 74 via two (or three  
18       if shielding is used) conductors 80. Printed circuit board 74  
19       supports header 72 (10 gold plated square .025 inch x .025 inch  
20       posts), a diode 82 and one end of the two (or three if  
21       shielding is used) conductors 80. Holes through boards 74 and  
22       78 are used to attach the boards to housing 65, which in this  
23       embodiment is an off-the-shelf plastic enclosure. (Note: It is  
24       will be understood that boards 74 and 78 could be combined [or

1 perhaps eliminated] if a different switch and/or connector were  
2 used). An optional capacitor (not shown) can be used to shunt  
3 undesired RF energy to ground to reduce EMI, if desired. Diode  
4 82 (one of diodes 40 in FIG. 4A) is used in order to limit the  
5 number of high conductivity paths, which could otherwise result  
6 in erroneous vote tallies.

7

8       A pair of flanges 84 in FIG. 6 are affixed to the lower  
9 surface of housing 65 in spaced apart relationship and are  
10 directed outwardly in opposite directions. Flanges 84 provide  
11 essentially planar mounting structures that provide a large  
12 surface area (for secure adhesive bonding to the undersurface  
13 of table 12). Also, flanges 84 are offset or spaced apart on  
14 the lower surface of housing 65, so as to define an open  
15 channel (air gap) between the undersurface of table 12 and  
16 housing 65 of vote box 22, through which the adhesive backed  
17 flat ribbon cable assembly 20 extends.

18

19           J. Adapter Box

20

21       Anywhere along the adhesive backed ribbon cable 20  
22 (generally at one end), the electrical signals are coupled to  
23 the console via adapter box 18 enclosed in a housing 86, as  
24 illustrated in FIGS. 8 and 9. If housing 86 is located where

1        knees or hands can bump into it, the shape of housing 86 will  
2        be generally designed as described above with relation to  
3        housing 65 of each vote box 22. That is, housing 86 is  
4        generally constrained as follows: the overall height of the  
5        enclosure (like housing 65) is as small as is practical, in  
6        order to maximize unobstructed legroom under the table.  
7        Furthermore, the edges (front, and sides) of the housing are of  
8        sufficiently large radius (or the like) so as to deflect much  
9        of the bumping force upward into the rigid table undersurface.  
10      That is, a person's knee is gently deflected by the vote box  
11      and/or adapter box housing, rather than abruptly (painfully)  
12      impacting any vertical edge thereof. Toward this goal, the  
13      edges are of large radius, as illustrated in FIG. 8, or are  
14      sloped at about 45 degrees. Here it will be understood that  
15      the term "box" in "vote box" and "adapter box" does not  
16      restrict the shape of the housings nor flanges to a rectangular  
17      shapes. The vote boxes and adapter boxes can be basically  
18      round or basically elliptical, yet still provide flange and  
19      channel functions.

20

21        An opening slot 87 in the lower surface of housing 86 is  
22        chamfered to easily guide a mating electrical connector  
23        (similar to connector 70 in FIG. 10) into adapter box 18, so as  
24        to mate with a header 90 (10 gold plated square .025 inch x

1 .025 inch posts) illustrated in FIG. 11. Header 90 is affixed  
2 (e.g. soldered or staked) to a printed circuit board 92 that  
3 also has mounted thereon a connector 94 (an eight conductor  
4 shielded miniDIN), which can mate with a flexible round  
5 computer cable [like an Apple® printer cable)]. Adapter box 18  
6 electrically couples the ten conductors of flat ribbon cable  
7 assembly 20 to the nine conductors (or 10 with another choice  
8 [e.g. a shielded DB9 connector] of connector) in the round  
9 cross section cable 16. Two conductors of the ten conductor  
10 flat ribbon cable assembly 20 are electrically connected, by  
11 printed circuit board 92, to the shield of the round cross  
12 section cable 16. An optional capacitor (not shown) can shunt  
13 undesired RF energy to ground to reduce EMI.

14

15 Mounting flanges 96 (in FIG. 8 and FIG. 9) are essentially  
16 planar structures affixed in a spaced apart opposed  
17 relationship to a lower surface of housing 86. Flanges 96  
18 provide a large surface area (for secure adhesive bonding to  
19 the undersurface of table 12). Also, flanges 96 are offset, or  
20 spaced apart, on the lower surface of housing 86, so as to  
21 define an open channel (air gap) 88 between the undersurface of  
22 table 12 and the lower surface of adapter box housing 86,  
23 through which adhesive backed flat ribbon cable assembly 20  
24 extends. Here it will be understood that the functions of the

1       housings like 86 and flanges like 96 can be provided by a more  
2       integrated, molded structure (e.g. one or more injection molded  
3       parts thereby resulting in lower production and assembly  
4       costs).

5

6                   K. Self-Adhesive Ribbon Cable and Connectors

7

8       In this preferred embodiment, flat ribbon cable assembly  
9       20 (of FIG. 2) is, for example, an adhesive backed multi-  
10      conductor (ten in this embodiment) flat cable, an enlarged view  
11      of which is illustrated in FIG. 12. In this embodiment, a  
12      multi-conductor flat cable 100 with an adhesive layer 102  
13      affixed to one side is used as flat ribbon cable assembly 20.  
14      As will be explained in more detail presently, flat cable 100  
15      and adhesive layer 102 are provided separately and affixed  
16      together to form adhesive backed flat ribbon cable assembly 20.  
17      Generally, adhesive layer 102 has a release liner/backing that  
18      gets removed during the installation process.

19

20       In addition, to adhesive backed multi-conductor flat  
21      ribbon cable assembly 20, a two-part press-on insulation  
22      displacement connector 115 is illustrated in FIG. 12.  
23      Connector 115 includes a receiving part 110 and a mating  
24      penetrating part 112. Penetrating part 112 has electrically

1 conductive blades/contacts 116 that penetrate the insulation of  
2 flat ribbon cable assembly 20 and make electrical contact with  
3 the electrical conductors therein. Blades/contacts 116 extend  
4 through adhesive layer 102 and are received by mating slots in  
5 receiving part 110.

6

7 By properly timing the application of pressure on parts  
8 110 and 112 during installation, adhesive layer 102 is  
9 substantially squeezed out from between parts 110 and 112,  
10 thereby allowing the correct mating between parts 110 and 112.  
11 (i.e. this forces out a substantial portion of the adhesive  
12 backing from between the connector parts). For example,  
13 minimal pressure for at least 1 second suffices and provides a  
14 subtle-but-very-significant benefit: connectors 115 can be  
15 installed anywhere it is desired to situate a vote box 22 or an  
16 adapter box 18 along the flat ribbon cable assembly 20 without  
17 the complexity of first removing adhesive layer 102 at the  
18 installation point. Thus, the 'first remove adhesive layer  
19 102' option is not preferred (but it is still possible). An  
20 additional benefit is an adhesive bond produced by the  
21 remaining adhesive layer 102 between parts 110 and 112, thereby  
22 avoiding connector failures due to parts 110 and 112  
23 inadvertently separating.

1       IV. Installation of the Under-Table-Network

2

3           A. Converting adhesive backed ribbon cable

4

5           In one preferred embodiment, the information conductors  
6       for the conference-table-based wired information system 10 are  
7       copper wires in a ten conductor ribbon cable 100 (see FIG. 12)  
8       with 0.1 inch pitch. In this embodiment, a carefully chosen  $\frac{1}{2}$   
9       inch wide, double-sided adhesive tape 102 is bonded all along  
10      the  $\frac{1}{2}$  inch wide ribbon cable 100. Double-sided adhesive tape  
11      102 has a release liner that is not removed, yet. A laminating  
12      machine 138 to accomplish this converting process is shown in  
13      FIGS. 14 and 15. By turning a crank and, hence, take-up reel  
14      140, adhesive tape 102 from a reel 142 and ribbon cable 100  
15      from a reel are joined or pressed together by a compression  
16      unit 146. Compression unit 146 includes an aligner and  
17      pressure roller block, which is made of UHMW (ultra high  
18      molecular weight) plastic that has an extremely low coefficient  
19      of friction (lower than Teflon® and also has a low surface  
20      energy (it bonds poorly with adhesives). This allows the  
21      bonded ribbon-with-adhesive to be pulled with low friction (and  
22      without undesired adhesive-sticking to the block). The aligner  
23      part (a half inch wide slit in the UHMW) of keeps the ribbon  
24      and adhesive tape edges in accurate registration with each

1 other and with the pressure rollers. The pressure rollers are  
2 biased toward each other by a spring in order to firmly and  
3 uniformly press the adhesive tape onto the ribbon cable for a  
4 permanent bond along the length of the ribbon cable. The  
5 completed self-adhesive-ribbon-cable 20 is then reeled up onto  
6 take-up reel 140. Of course, this can be motorized or  
7 performed on a commercial converting machine. Since adhesive-  
8 backed-ribbon-cable 20 is not currently commercially available,  
9 laminating machine 138 was designed and built to efficiently  
10 and accurately combine the components that are commercially  
11 available, i.e. ribbon cable 100 and double sided adhesive tape  
12 102.

13

14           B. Measuring the length of converter ribbon

15

16           Two silicone rubber coated wheels 150 and 152 (see FIG.  
17 15) lightly 'pinch' the adhesive-backed-ribbon and rotate at a  
18 rate proportional to the linear speed of the adhesive-backed-  
19 ribbon. Wheel 152 contains a small permanent magnet (not  
20 shown) that is sensed by a magnetic reed switch 154 (or Hall  
21 effect sensor). Magnetic reed switch 154 is connected in  
22 parallel with the '=' key on a calculator 156. In this  
23 specific application, when calculator 156 is 'programmed' with  
24 the key sequence , '0.245' , '+' , '+' then each revolution of

1       the magnet adds the conversion factor 0.245 to the previous  
2       sum, thereby giving a direct readout calibrated in feet. (The  
3       specific value '0.245' was empirically determined by running a  
4       pre-measured length, e.g. 10 feet, of ribbon cable through  
5       rollers 150 and 152 and calculating the equivalent 'feet per  
6       revolution' of roller 152). Using this method (or a similar  
7       measuring technique), the length of the finished adhesive-  
8       backed-ribbon can be easily determined.

9

10       C. Installing cables and boxes on a table undersurface

11

12       In one preferred embodiment, the undersurface of table 12  
13       is cleaned of dust, dirt, wax, oil or (anything that may  
14       prevent excellent adhesive bonding). Next, a person installing  
15       the system (e.g. the customer buying the system) decides how  
16       many voters will be supplied with vote boxes 22 around  
17       conference table 12. Also, the person decides approximately  
18       where each vote box 22 will be located and temporarily adheres  
19       one wax board 120 (see FIG. 13) at each chosen location. Wax  
20       boards 120 are covered with wax (or other suitable non-stick  
21       coating) on virtually all surfaces except one of the two large  
22       surfaces 122. In this preferred embodiment two of 3M®'S easily  
23       removable Command Strips™ 124 are adhered to large surface 122  
24       of wax board 120. Command Strips™ 124 temporarily bond wax

1 board 120 to the underside of table 12. Each wax board 120 is  
2 temporarily adhered by removing a release liner from the  
3 exposed surface of each of the Command Strips™ 124 and  
4 pressing the exposed adhesive against the undersurface of table  
5 12 at the chosen location (in the preferred embodiment, a few  
6 inches in from the table's edge).

7

8 Referring specifically to FIG. 13, a mid installation step  
9 is illustrated. In this step only a short segment of self-  
10 adhesive ribbon cable 20 bonded to the undersurface of table 12  
11 is illustrated for simplicity. Self-adhesive flat ribbon cable  
12 assembly 20 is rolled over wax boards 120 that are temporarily  
13 adhered to the undersurface of table 12 in order to reserve an  
14 air gap 126 for subsequent installation of connectors 115.  
15 After rolling on the full length of self-adhesive flat ribbon  
16 cable assembly 20, wax boards 120 are removed leaving air gaps  
17 126. A receiving part 110 of a connector 115 is placed in each  
18 air gap 126 and a mating penetrating part 112 is installed, as  
19 explained above. Thus, all air gaps 126 are filled with  
20 connectors 115. It will be understood that a tool (e.g. a pair  
21 of parallel-jaw pliers with one narrow jaw) can be used to fit  
22 one (narrow) jaw into gap 126 and the other jaw below  
23 penetrating part 112, in order to press together connector 115.

1       The function of each wax board 120 is to reserve the small  
2       air gap 126 between adhesive backed flat ribbon cable assembly  
3       20 and the undersurface of table 12. At locations where there  
4       are no wax boards 120, adhesive backed flat ribbon cable  
5       assembly 20 is fairly taut and securely bonded to the  
6       undersurface of table 12. If no wax boards 126 (or similarly  
7       operating device) were used, adhesive backed flat ribbon cable  
8       assembly 20 could become damaged [stretched and  
9       broken/weakened] when a connector 115 is applied to flat ribbon  
10      cable assembly 20. Note that each wax board 120 has a  
11      temporary adhesive surface 122 and a waxy (e.g. wax or silicone  
12      coated) opposite surface. The waxy surface will prevent  
13      undesired bonding between wax board 120 and the adhesive  
14      backing on flat ribbon cable assembly 20. In addition, each  
15      wax board 120 may support printed information (e.g.  
16      installation instructions like "Adhere this board where each  
17      vote button box will be."). It will be understood that while a  
18      specific embodiment of wax boards 120 is disclosed other  
19      embodiments can be constructed from various materials such as  
20      'vinyl coated foam core boards' as used for Venetian blinds.  
21      These are smooth, light weight, low cost and have already  
22      rounded edges.

1       Once connectors 115 are in place, a vote box 22 is applied  
2       using, for example, the following steps. A vote box 22 is  
3       correctly oriented and lightly pressed to the undersurface of  
4       table 12 such that the chamfered opening 68 in the bottom of  
5       housing 65 and pins 72 in vote box 22 accurately align with the  
6       connector 115 that is attached to adhesive backed ribbon cable  
7       20. Once this alignment is acceptable, vote box 22 is pressed  
8       more forcefully to the table. Finally, vote box 22 is pressed  
9       firmly against undersurface of table 12, in order to begin the  
10      'permanent'-but-cleanly-removable bond. The bond should be  
11      undisturbed for about 24 hours (for the preferred kind of  
12      adhesive tape) before full strength is achieved. The previous  
13      steps are repeated to place and connect each of the remaining  
14      vote boxes 22.

15

16       Next adapter box 18 is positioned and attached to the  
17       undersurface of table 12. As explained above, the purpose of  
18       adapter box 18 is to adapt the wide and flat ribbon cable  
19       assembly 20 to the more flexible 'compact-round' cable 16.  
20       Note, although the flat ribbon cable is very orderly [neatly  
21       dressed] and highly durable when bonded to the table surface,  
22       it is not as durable, nor as orderly when not bonded.  
23       Therefore, a round cable, which flexes easily in all radial  
24       directions, is recommended for interface to information display

1       console 15 and optional interface to a personal computer or the  
2       like.

3

4       Adapter-box 18 can be plugged in just as vote boxes 22  
5       were. However, a different method for determining the 'correct  
6       orientation' of adapter-box 18 may be utilized. That is,  
7       adapter box 18 need not be near the table's edge. It may be  
8       located more toward the center of the table (e.g., near a cord-  
9       access-hole in table 12). Nevertheless, correct electrical  
10      interconnection, must be assured to avoid plugging adapter box  
11      18 in backwards, and therefore rendering it nonfunctional.  
12      Correct orientation an be achieved by placing adapter box 18  
13      such that a box label (not shown) is nearest the outermost edge  
14      of adhesive backed flat ribbon cable assembly 20. Here, the  
15      'outermost edge' is the same edge of adhesive backed flat  
16      ribbon cable assembly 20 that runs closer to the perimeter of  
17      table 12 when near vote boxes 22. This edge may be easily  
18      identified by a red stripe (or other color) along its length.

19

20      Thus, by now it will be apparent that an easy-to-install  
21      do-it-yourself kit can be organized (using the components,  
22      methods and tools already described) containing all, or nearly  
23      all, of the parts and tools needed to install a table-based  
24      wired information system. Thus, for the first time ever, the

1 innovative modular peel-and-stick component design and  
2 installation methodology enables ordinary office workers to  
3 perform the do-it-yourself installation in their own conference  
4 rooms. In turn, this enables low cost distribution and rapid  
5 market growth.

6

7 It should be understood that innovations disclosed herein  
8 can be more generally applied than explicitly stated. For  
9 example, it will be understood by those skilled in the art,  
10 that everywhere terms like "undersurface of a table" and 'table  
11 undersurface' are used one could substitute 'bench surface',  
12 'counter surface', 'wall surface', 'ceiling surface',  
13 'enclosure surface', 'vehicle interior surface', 'fence  
14 surface', 'floor surface' or the like. Also, the term "table"  
15 is intended to include any surface or device designed to have  
16 people congregate around for making decisions, playing games.  
17 etc. Further, the terms "vote" and "voting" are intended to  
18 include the operation of one of the vote boxes.

19

20 Thus an improved table-based wired information system has  
21 been disclosed which is easy to install and use and which is  
22 highly versatile. A system has been disclosed that is  
23 'permanent'-but-cleanly-removable bonded to a table. It should

1 be noted that the system is bonded sufficiently to deter theft,  
2 unlike other wireless or loosely affixed voting systems.

3

4 Various changes and modifications to the embodiments  
5 herein chosen for purposes of illustration will readily occur  
6 to those skilled in the art. For example, the specific cables  
7 can be modified by including more or less conductors and by  
8 using different adhesive materials. To the extent that such  
9 modifications and variations do not depart from the spirit of  
10 the invention, they are intended to be included within the  
11 scope thereof which is assessed only by a fair interpretation  
12 of the following claims.

13

14 What is claimed is: